



QUERY BY IMAGE CONTENT USING DISCRETE WAVELET TRANSFORM

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Abstract: - The Content-based image retrieval systems allow the user to iteratively search image databases looking for those images which are similar to a specified query image. The core part of CBIR or Query by Image Content System is feature extraction. Selection and ranking of relevant images from image collections remains a problem in content-based image retrieval. This problem becomes even more visible and acute when attempting to merge and rank multiple result sets retrieved from a distributed database environment. In this system discrete wavelet transform is used for feature extraction. This system presents a offline content based image retrieval system with advantages like (1) reduce the computation requirement for the content similarity matching and (2) provide a higher retrieval precision. The primitive features of an image like texture, colour, and shape are extracted and used as the basis for a similarity check between images.

Key-Words: - CBIR, DWT, QBIC.

I. INTRODUCTION

Problems with traditional methods of image indexing have led to the rise of interest in techniques for retrieving images on the basis of automatically-derived features such as color, texture and shape – a technology now generally referred to as **Content-Based Image Retrieval (CBIR)**. The difficulties of expressing multimedia contents in high level concepts limited the performance of the text-based search engines to retrieve the desired multimedia content efficiently and effectively. Retrieving

images from a large database according to the semantic meanings is a challenging problem, due to the lack of mature artificial intelligence mapping semantic meanings to low-level descriptors. Such complexity also raises scalability issues for the size of the database, especially when the database is distributed over multiple servers. A CBIR system evaluates the similarities between the query and target images according to low-level features, such as color, texture, and shape, embedded within the images. Content-based image retrieval (CBIR) has become one of the most active research areas in multimedia signal processing.

Databases of art works, satellite and medical imagery have been attracting more and more users in various professional fields — for example, geography, medicine, architecture, advertising, design, fashion, and publishing. Effectively and efficiently accessing desired images from large and varied image databases is now a necessity [1].

A. Definition

CBIR or **Content Based Image Retrieval** is the retrieval of images based on visual features [2]. The features the color, shape or texture. "Content-based" means that the search will analyze the actual contents of the image. The term 'content' in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself. Reasons for its development are that in many large image databases, traditional methods of image indexing have proven to be insufficient, laborious, and extremely time

consuming. These old methods of image indexing, ranging from storing an image in the database and associating it with a keyword or number, to associating it with a categorized description, have become obsolete. This is not **CBIR**. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. It involves two steps [3].

Feature Extraction: The first step in the process is extracting image features to a distinguishable extent.

Matching: The second step involves matching these features to yield a result that is visually similar.

B. Applications of CBIR

Examples of CBIR applications are [4]

Crime prevention: Automatic face recognition systems, used by police forces.

Security Check: Finger print or retina scanning for access privileges.

Medical Diagnosis: Using CBIR in a medical database of medical images to aid diagnosis by identifying similar past cases.

Intellectual Property: Trademark image registration, where a new candidate mark is compared with existing marks to ensure no risk of confusing property ownership

C. CBIR Systems

Several CBIR systems currently exist, and are being constantly developed. Examples are [5]

Query by Image Content was developed by IBM, Almaden Research Centre, to allow users to graphically pose and refine queries based on multiple visual properties such as colour, texture and shape [4]. It supports queries based on input images, user-constructed sketches, and selected colour and texture patterns [2].

VIR Image Engine by Virage Inc., like QBIC, enables image retrieval based on primitive attributes such as colour, texture and structure. It examines the pixels in the image and performs an analysis process, deriving image characterization features [6].

VisualSEEK and **WebSEEK** were developed by the Department of Electrical Engineering, Columbia University. Both these systems support colour and spatial location matching as well as texture matching [5].

NeTra was developed by the Department of Electrical and Computer Engineering,

University of California. It supports colour, shape, spatial layout and texture matching, as well as image segmentation [7].

MARS or **Multimedia Analysis and Retrieval System** was developed by the Beckman Institute for Advanced Science and Technology, University of Illinois. It supports colour, spatial layout, texture and shape matching [8].

Viper or **Visual Information Processing for Enhanced Retrieval** was developed at the Computer Vision Group, University of Geneva. It supports colour and texture matching [8].

Photobook, the Developer Vision and Modeling Group, MIT Media Laboratory, Cambridge, MA. It implements three different approaches to constructing image representations for querying purposes, each for a specific type of image content: faces, 2D shapes and texture images [9].

II. PROPOSED METHOD

A. Objective

The overall objective of this paper is to present an extended application of Content-Based Image Retrieval (CBIR) using discrete wavelet transform. In the proposed approach, feature of each image is extracted and store into the database. When the query image comes, its feature also extracted and compares with the database features. Depends on the similarity top images will be displayed to the screen. Discrete wavelet transform is used for effective feature extraction.

B. Visual Feature Extraction Method.

The core part of CBIR system is feature extraction. In this paper, discrete wavelet transform is used for feature extraction.

1) Overview

The discrete wavelet transform is a very useful tool for signal analysis and image processing. One-dimensional discrete wavelet transform (1-D DWT) decomposes an input sequence into two components (the average component and the detail component) by calculations with a low-pass filter and a high-pass filter. Two-dimensional discrete wavelet transform (2-D DWT) decomposes an input image into four sub-bands, one average component (LL) and three detail components (LH, HL, HH) as shown in Figure1[10].

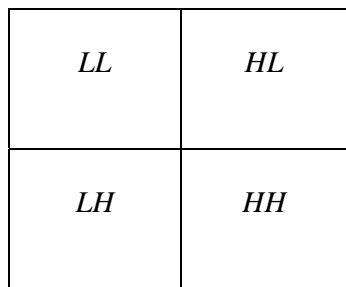


Figure 1. The Result of 2D DWT Decomposition

2) 2D-Wavelet Transform of an Image

Given an image, we will create 4 new sub-images to replace it. To create these four sub-images, we break the original image into 4 pixel blocks, 2 pixels to a side. If the original image has size $2^n \times 2^n$, we should have 2^{2n-2} blocks. Now for each block, the top-right pixel will go directly into the top-right sub image. The bottom-left pixel goes directly into the bottom-left sub image. And the bottom-right pixel goes into the bottom-right sub image. So these 3 sub images will look like a coarse version of the original, containing 1/4 of the original pixels.

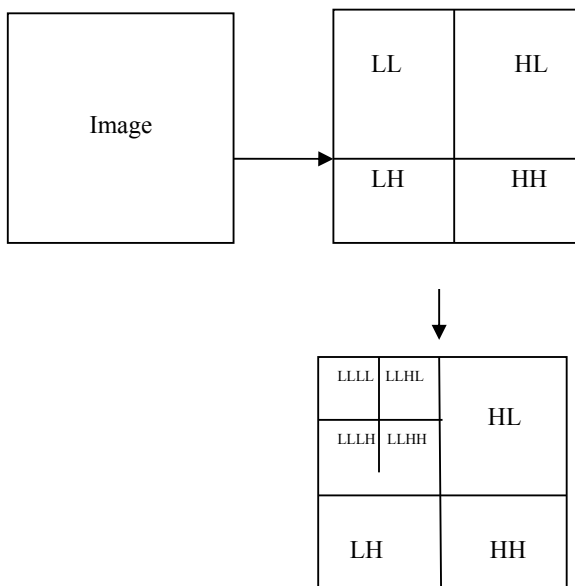


Figure 2. 2D Wavelet Transform of an Image

The top-left pixel of each block does *not* go directly into the top-left sub image. Rather, all 4 pixels of the block are averaged and placed into the top-left sub image. So the top-left sub image is effectively a scaled down version of the original image at 1/4 the original size. But it does not contain any of the original pixels

itself. This process can be repeated now for the top-left image. [12].

The top left image is called average component and the remaining part is called detailed component. For next decompositions we will neglect the detailed component. HL part contain the vertical edge information and LH part contain horizontal edge information and the HH part contain the diagonal information.

C. Feature Extraction Using DWT (Discrete Wavelet Transform)

1) Color

Color, texture features of the top-left image will give the feature of the whole image. For color feature extraction, I implemented color moment and calculated the mean, variance and standard deviation of three basic colors (red, green and blue). Mean, variance, and standard deviation are defined for an image of size $N \times M$ in the following equations.

$$\text{Mean } \bar{x} = \frac{1}{NM} \sum_{i=1}^N \sum_{j=1}^M x(i,j) \tag{1}$$

Variance

$$\delta^2 = \frac{1}{MN} * \sum_{i=1}^N \sum_{j=1}^M (x(i,j) - \bar{x})^2 \tag{2}$$

Standard Deviation

$$\delta = \sqrt{\frac{1}{MN} * \sum_{i=1}^N \sum_{j=1}^M (x(i,j) - \bar{x})^2} \tag{3}$$

where $x(i, j)$ is the value of the pixel in row i and column j .

2) Texture [13]

Algorithm for calculating wavelet signatures

1. Let I be the image of size $w \times w$
2. Divide the image I into four bands I_1, I_2, I_3, I_4 based on Haar wavelet of size $w/2 \times w/2$
3. Compute Signatures fr for I_2, I_3, I_4
4. Now take the image I_1 and divide it into 4 bands namely $I_{11}, I_{12}, I_{13}, I_{14}$ of size $w/4 \times w/4$
5. Compute signatures fr for I_{12}, I_{13}, I_{14}
6. Again take the I_{11} and divide it into 4 bands
7. namely $I_{111}, I_{112}, I_{113}, I_{114}$ of size $w/8 \times w/8$.

Now we obtain 10 signatures then stop the process. The Wavelet signature (texture feature representation) is computed from sub image as follows,

$$f_r = \sqrt{\frac{\sum c_{ij}^2}{i \times j}} \quad (4)$$

C_{ij} is the representation of the intensity value of all elements of sub image and $i \times j$ is the size of the sub image. In the case of texture features also I calculated mean and deviation.

3) Shape

In the case of shape information, I considered remaining three parts. It has vertical, horizontal and diagonal information. [14]

D. Similarity Measures

For measuring the similarity between the database image and query image, the Euclidean distance or Sum-of-Squared-Differences (SSD) are calculated.

$$SSD(f_q, f_t) = \sum_{i=0}^{n-1} (f_q - f_t)_i^2 \quad (5)$$

Here $f_q = f_q[0], f_q[1] \dots f_q[n]$ represents the query feature vector, $f_t = f_t[0], f_t[1] \dots f_t[n]$ denotes the target feature vector, and n is number of features in each feature vector.

III. EXPERIMENT RESULTS

To demonstrate the project application, implemented the following example.

A. Example

The application can be selected by Build Solution and then select Start without Debugging. The application window started. The execution of the system can be expressed in several steps.

Step: 1 Creating the Database

Create the database, for that load the image in the window, apply DWT and extract the features store that features into the database.

In feature extraction, the features like color, texture and shape etc. has to extract from both database image and the query image. Before storing all images into database, all the features has to be extracted and along with the image,

feature also have to store into the database also extracted and compare with the already extracted features in the database and returned the images, order by their similarity.

Example of load image window is given below.

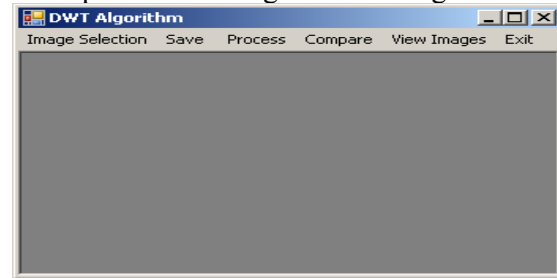


Figure 3. Main Application Window

Image Selection- To load the image into the picture box as well as select the query image.

Save- Save the images into the Database

Process- Apply DWT (Discrete Wavelet Transform Process).

Compare- Compare the database images as well as query image.

View Image- View the output window.

Exit- Exit from the window.

When we are selecting the item image selection one image will be loaded into the picture box of the application window. An example of loading an image is given below. When we are loading the image height and the width of the image is calculated. And then low pass filtering and high pass filtering will be performed on the image.

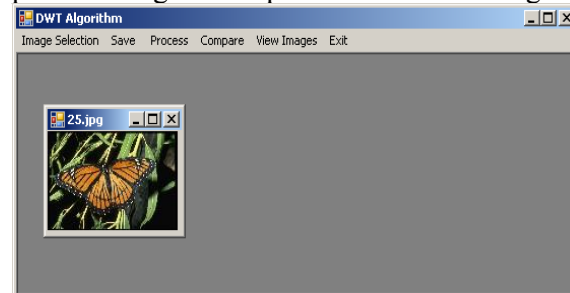


Figure 4. Example of Loading the Image

When we select the item process, low pass filtering and high pass filtering will be performed.

Two-dimensional discrete wavelet transform (2-D DWT) decomposes an input image into four sub-bands, one average component (LL) and three detail components (LH, HL, HH) as shown in Figure 5.

It will create four sub images. The top-left sub image is effectively a scaled down version of the original image at 1/4 the original size.

The LL region will contain all the in

formations about the image and other sub images can be neglected.

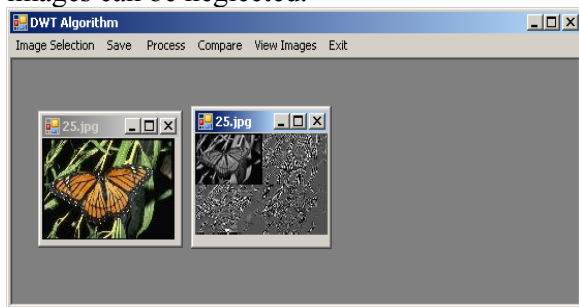


Figure 5. Performing DWT

Perform DWT (Discrete Wavelet Transform) in each image and store all the features into the database. In the main application window, each image load in the Picture Box using Image Selection menu then select Save menu ,the image will be save into the database. Then select Apply DWT, the image annotation will take place and save the values into the database.

Like this way create an image database of two hundred uncompressed JPEG images. The following figure depicts a sample of images in the database

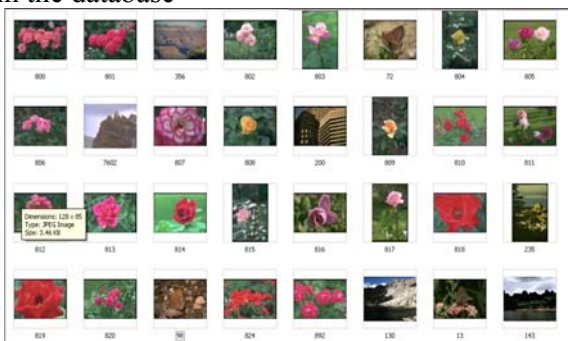


Figure 6 Image Database

Step 2: Get the query Image

After creating the image database, select Input menu item, for getting the query image. Image will be loaded in the Picture Box using Load button then select Save button ,the image will be save into the database. Then select Apply DWT button, the image annotation will take place and save the values into the file named input file.

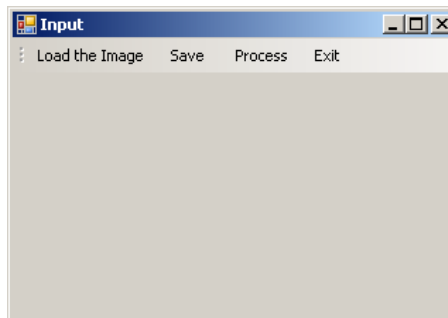


Figure 7. Query Image Window
Example of loading the input image



Figure 8. Example of Query Image

Step 3 Comparison

After the query image is loaded compare with the database image. Comparison window is given below.

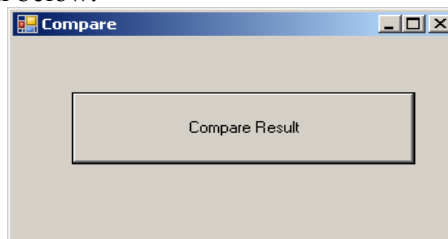


Figure 9. Comparison Window

The extracted feature of the query image will be compared with the database features. Then the images will be ranked according to their similarity.

The final output screen is given below.

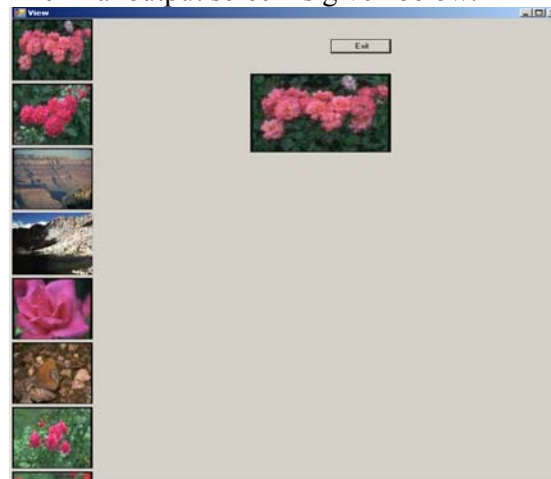


Fig.10 Output window

IV. CONCLUSION

The dramatic rise in the sizes of images databases has stirred the development of effective and efficient retrieval systems. The development of these systems started with retrieving images using textual connotations but a later introduced image retrieval based on content. This came to be known as CBIR or Content Based Image Retrieval. Systems using CBIR retrieve images based on visual features such as color, texture and shape, as opposed to depending on image descriptions or textual indexing. We have proposed a simple algorithm for content-based image retrieval based on DWT. According to the tests, the best decomposition level and wavelet for this purpose is the 2nd-level wavelet with support-size 4, otherwise some energy part will be lost. The accuracy in the retrieval will be high.

V. REFERENCES

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